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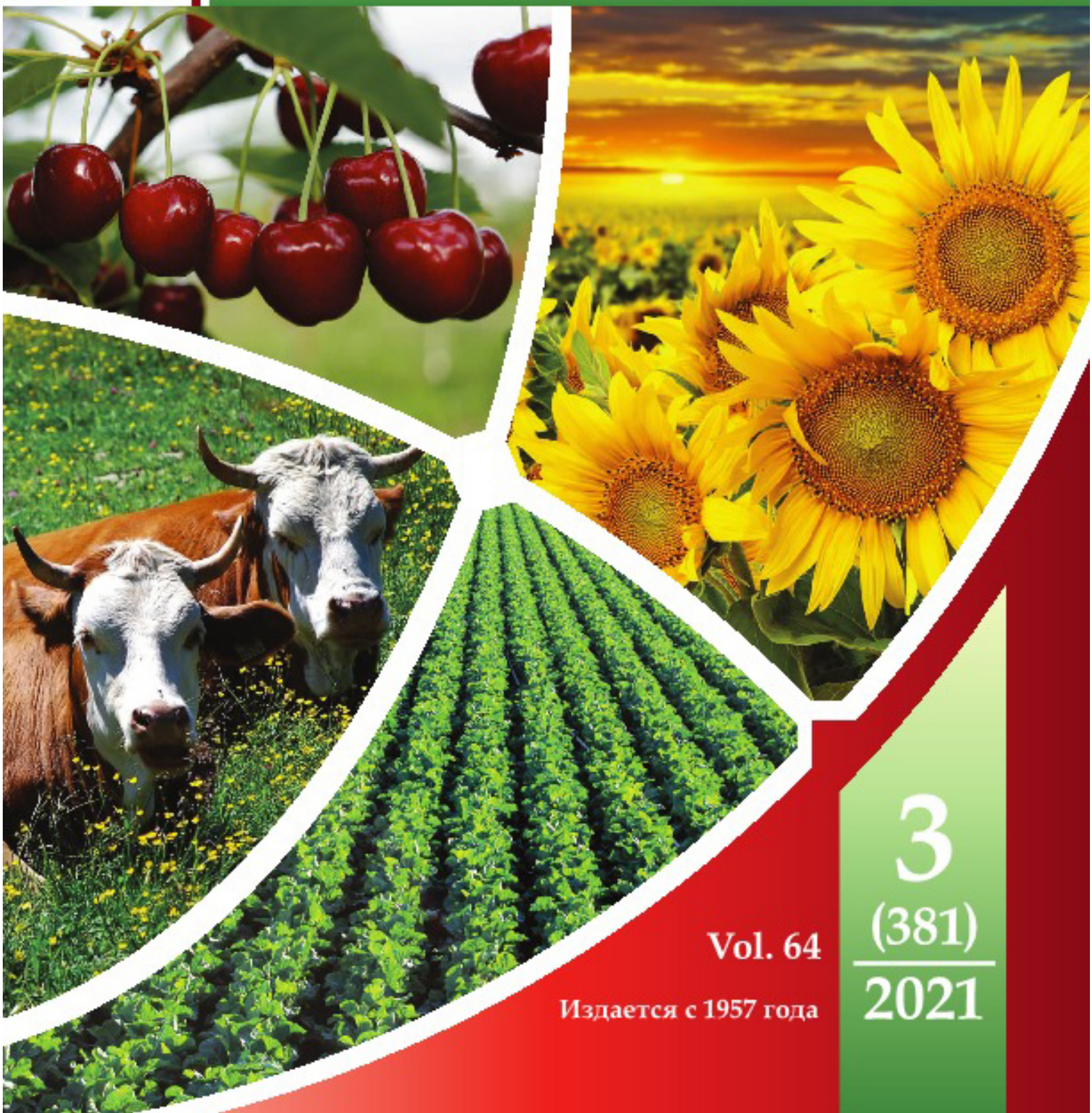

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THE EFFECTIVENESS OF A HUMUS-BASED AGROCHEMICAL ECO-SP ON SPRING CEREAL CROPS UNDER THE CONDITIONS OF THE KURSK REGION'S SOIL AND CLIMATE

V.I. Lazarev, Zh.N. Minchenko, A.Ya. Bashkatov

Kursk Federal Agrarian Scientific Centre, city of Kursk, Russia

The report summarizes the findings of a study on the efficacy of the humus-based pesticide ECO-SP on spring cereal crops under the conditions of the Kursk region's chernozem soils. The treatment of seeds with preparation ECO-SP boosted germination energy of spring wheat seeds by 2%, spring barley seeds by 4%, laboratory germination by 1 and 2%, respectively, and had a stimulating influence on the growth of spring grain crop seedlings. The preparation's application under pre-sowing cultivation in a dose of 2.5 l/ha and double treatment of crops in the phases of tillering and the beginning of emergence in a dose of 1 l/ha, ECO-SP increased the number of productive stems of spring wheat by 24 pcs/m, the number of grains in the ear - by 1.1 pcs, weight of 1000 grains - by 0,9 g, grain nutrition - by 18 g/l.; spring barley - by 27 pcs/m, 0,4 pcs, 0,7 g and 20 g/l, respectively. This helped to increase spring barley yield by 6.5 c/ha or 13.8%, and spring wheat yield by 6. 9 c/ha or 16.6%, increased the gluten content in spring wheat grain by 0.8%, increased the coarseness of spring barley grain, its starch content and extractive substances, contributed to a slight increase in protein content (by 0.2%), but this increase was within the requirements for malting barley (9-12%). Economic efficiency calculations revealed that using preparation ECO-SP on spring barley crops was economically successful, providing 30066,21 RUB/ha conditional net revenue at the cost of 1 kg of grain equivalent to RUB 436.96 and a profitability level of 128.8%. The efficiency of the ECO-SP preparation on spring wheat harvests was even greater: the presumed net revenue was 34626.21 RUB/ha, the cost per 1 kg of grain was RUB 436.96, and the profitability level was 148.3%.

Key words: *spring wheat, spring barley, ECO-SP humus-based agrochemical, yield, yield structure, gluten content, septoriosis, economic efficiency.*

Introduction

Spring cereals are the main and most productive cereal crops in the Kursk Region's sown area structure. According to the arable farming system, spring crops are sown on 447-572 thousand hectares, or 50.1-60.3% of the total area of the grain area. Spring cereal crop productivity varies significantly from year to year: spring wheat yields in the recent decade ranged from 2.10 t/ha in 2011 to 4.95 t/ha in 2019, while spring barley yields ranged from 1.89 t/ha in 2010 to 4.68 t/ha in 2020. [1]. This variance is connected to the year's weather circumstances, crop agronomic techniques, and the combination of these factors [2, 3].

Spring crop yields can only be high and stable with the broad adoption of current agricultural cultivation technologies that organically integrate the principles of intensification, biologization, and resource conservation [4, 5, 6].

Modern intensive technologies are mostly based on chemical-technogenic intensification methods (mineral fertilisers, pesticides, etc.). The cost of conventional mineral fertilizers as a means of intensification, on the other hand, is not always justified by yield benefits [7, 8]. Furthermore, the amount of fertilizer applied does not entirely compensate for the mineral nutrients lost in the soil, resulting in a loss in soil fertility [9].

As a result, there is an urgent need to identify new additional resources that may be employed to optimize plant nutrition and produce better results. stable harvests of quality produce, while ensuring environmental sustainability. These resources may include post-harvest leftovers, green manure, local mineral and organic fertilizers, and biological fertilizers [10,11,12].

This paves the way for the development and - implementation of new crop cultivation trends based on the use of biological preparations, plant growth regulators, and biofertilizers to improve plant immunity to the most dangerous pathogens, the use of which is becoming more cost-effective and environmentally friendly [13,14,15].

ECO-SP, a humus-based fertilizer made from plant material (lowland peat), contains humic and fulvic acids, plant hormones, amino and simple organic acids, chelated microelements, and beneficial soil microorganisms. ECO-SP enhances plant anti-stress resistance to illnesses and unfavorable environmental circumstances, has excellent chemical purity and solubility, and boosts crop output and product quality. The product is intended for seed and foliar application and can be used throughout the growing season (from seed treatment to supplementary fertilisation after plants have been subjected to stress).

The goal of this research was to establish the efficacy of the agrochemical ECO-SP, which is based on humus compounds, in the cultivation of spring wheat and spring barley in the soil and climatic conditions of the Kursk region.

Materials and procedures

The effectiveness of application of the humus-based agrochemical ECO-SP on spring grain crops was studied in 2018-2020 in the experiment of the Laboratory of Field Crops Cultivation Technologies and Ecological Land Assessment of FSBSI "Kursk FASC" with the following crop rotation: spring barley - soybean - spring wheat. The trial included the use of ECO-SP - during pre-sowing cultivation as well as crop treatment during the tillering and emergence phases.

The soil of the sample plot is typical heavy-loamy black soil. The humus content in the arable layer is 6.0-6.2%, the mobile phosphorus level (according to Chirikov) is 10.1-14.5%, and the exchangeable potassium level (according to Maslova) is 16.8-19.0 mg/100 g of soil. The soil reaction is neutral (pH 6.8-7.0).

In the field experiment, the versions were stacked sequentially in a single tier. Repetition in the experiments is triple. The plots were in the form of an elongated rectangle with a recording area of 200 m^2 (4x50).

Fieldwork on the test site was carried out in the best agrotechnical terms using the released varieties in the region: spring wheat - Daria and spring barley Prometheus. Sowing was done with seeds that met the requirements of the 1st class sowing standard, at a rate of 5.5 mln germinated grains/ha for spring wheat and 5.0 mln germinated grains/ha for spring barley. The method of sowing is by row (row spacing 15 cm) followed by rolling with ring-spur rollers. Seed placement depth - 4-5 cm. Background mineral nutrition - N30P30K30. Spring cereal crop treatment with the humus-based agrochemical ECO-SP

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was carried out with a knapsack sprayer in accordance with the experiment scheme.

The crop was harvested using a Sampo 500 self-propelled direct harvester. Using an Infratek-1241 grain analyser, samples of spring grain crops were analyzed for crude gluten (spring wheat), protein, starch content, grain fat content (GOST-10840-76), and weight of 1000 grains (GOST-1084276). To process the experimental data, the method of variance mathematical analysis according to B.A. Dospehov (1985).

Results and Discussion

The use of the pesticide ECO-SP based on humus compounds on spring grain crops was proven to improve plant growth and development, yields, and grain quality. Thus, laboratory germination results of spring wheat and spring barley seeds show that treatment of seeds with agrochemical based on humus substances ECO-SP at a dose of 1 l/t increased the germination energy of spring wheat seeds (on the 3rd day of germination) by 2% and that of spring barley - by 4%, laboratory germinatio (Fig. 1).

The use of the humus-based pesticide ECO-SP improved spring cereal seed germination in the field. Calculation of spring wheat and spring barley standing density by test versions revealed that when ECO-SP preparation was treated under pre-sowing cultivation at a dose of 2.5 l/ha, there was a propensity to boost spring crop field germination by 1-2% compared to the control (Table 1, Fig. 2).

However, as compared to the control option, the application of the agrochemical ECO-SP based on humus components to the soil during pre-sowing cultivation resulted in improved grain crop growth and development, as well as the establishment of a stronger vegetative mass and root system.

During the trial years, the phytosanitary status of spring cereal crops was characterized by a moderate infection background. Rhynchosporium secalis and Helminthosporium infestations were reported *on spring barley crops, whereas* Septorianodorum *infections* were detected on spring wheat *harvests.* The use of the humus-based pesticide ECO-SP to spring cereal crops slowed the spread of those diseases. Thus, the application of ECO-SP under pre-sowing cultivation in a dose of 2.5 l/ha and double treatment of crops in the phases of tillering and the beginning of emergence in a dose of 1 l/ha contributed to a 5.5% reduction in Septoria spots, and the biological effectiveness of the preparation was 21.7% (Table 2).

The biological effectiveness of an agrochemical based on ECO-SP humus components on spring barley crops was 25.2% for rhinchosporiosis and 17.3% for helminthosporiosis (Table 3).

We believe that the comparatively high biological efficiency of ECO-SP in decreasing the occurrence of leafminer illnesses is related to the reasons that this pretreatment aided plant growth and development, resulting in stronger, more mature plants with higher resilience to numerous illnesses

ECO-SP was applied in pre-sowing cultivation at a rate of 2.5 l/ha, followed by double crop treatment in the tillering period at a rate of 1 l/ha and at the commencement of emergence at a rate of 1 l/ha.

Spring wheat yield increased by 6.9 c/ha, or 16.6%, when compared to the control (41.4 c/ha). The use of the EKO-SP agrochemical based on humic substances on crops of spring barley at the same time and in the same doses contributed to an increase in yield by 6.5 c/ha or 13.8% in comparison with the control (Table 4).

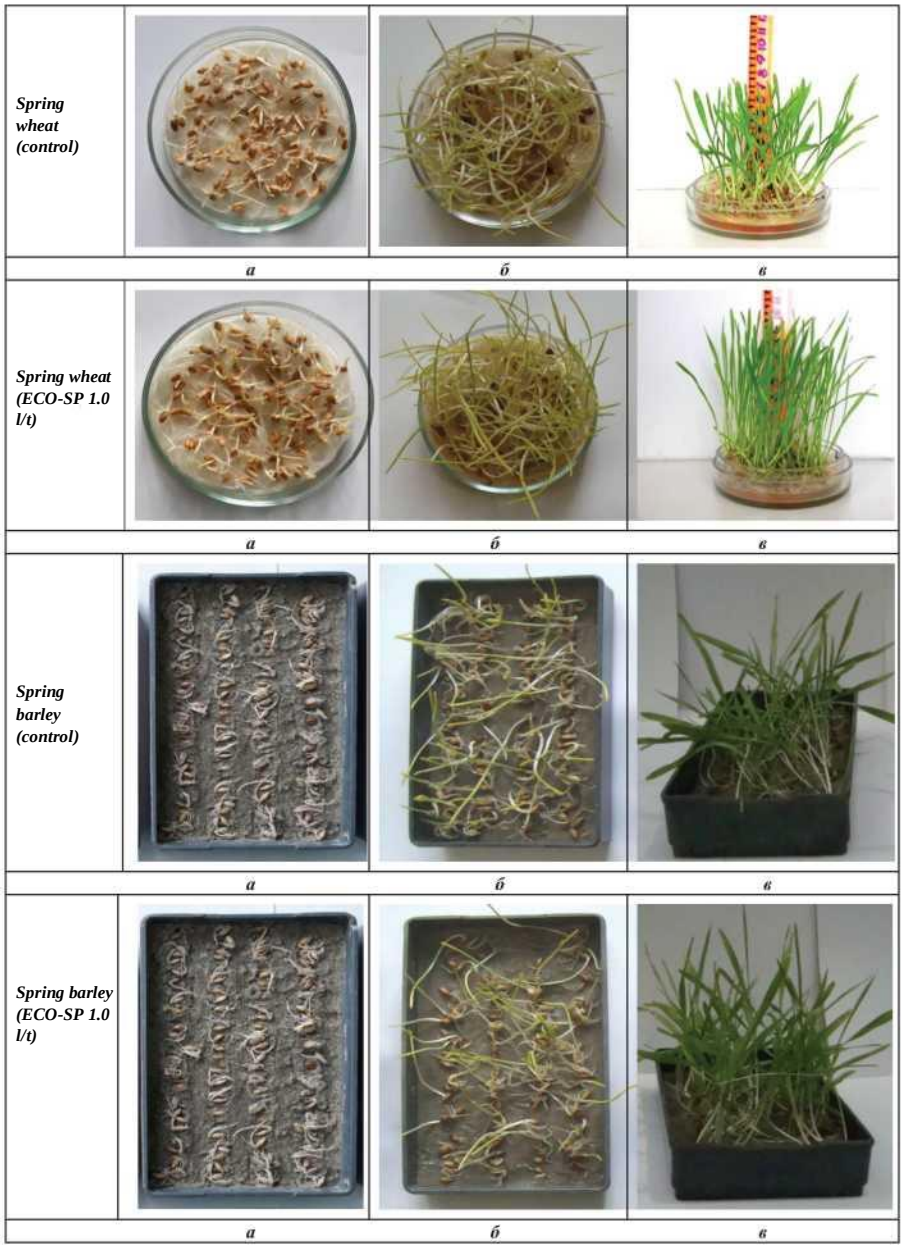

Fig. 1. The effect of the humus-based pesticide ECO-SP on spring cereal seed germination energy and laboratory germination (a - on day 3, b - on day 7, c - on day 14 of germination)

Table 1

The effect of ECO-SP on the germination of spring wheat and spring barley seeds in the field (2018-2020)

Variants	Number of plants sprouted per m^2	Field germination, %
Spring wheat		
Control - no treatments	502	91
ECO-SP (2.5 l/ha), applied under pre-sowing cultivation	506	92
Spring barley		
Control - no treatments	460	92
ECO-SP (2.5 l/ha), applied under pre-sowing cultivation	471	94

The preplant application of the EKO-SP and repeated treatment of crops at the tillering phase and phase of the beginning of stem elongation increased - the number of productive stems of spring wheat by 24 pcs/m, the number of grains in an ear by 1.1 pcs., the weight of 1,000 grains by 0.9 g, grain size - by 18 g/l (Table 5).

The use of the ECO-SP preparation on spring barley planting increased the number of productive stems by 27 pcs/m, the number of grains in an ear by 0.4 pcs, the weight of 1000 grains by 0.7 g, and grain nutrition by 20 g/l.

The use of ECO-SP on spring wheat crops had an effect on grain quality. Thus, when compared to the control, the application of the preparation ECO-SP under pre-sowing cultivation and double treatment of the crops in the phases of tillering and the beginning of emergence increased the crude gluten content in grain by 0.8% and the protein content by 0.3% (Table 6).

ECO-SP was used to ensure the production of spring barley grain that satisfied brewing standards: the plenitude was 8.55%, the starch content was 51.6%, and the protein level was 11.2%. Grain coarseness in this variant was estimated at 96.4% (with the standard being 95% for grade 1) (Table 7).

The preplant application of the EKO-SP and - repeated treatment of crops at the tillering phase and phase of the beginning of stem elongation contributed to a certain increase in the protein content in spring barley grain, by 0.2%, but this increase was within the requirements for brewing barley (9-12%).

Calculations of cost-effectiveness revealed that using the humus-based pesticide ECO-SP on spring cereal crops was cost-effective (Table 8).

Thus, the application of ECO-SP under pre-sowing cultivation at a dose of 2.5 l/ha and a double treatment of crops in the tillering and emergence - phase at a dose of 1 l/ha increased the yield of spring barley by 6.5 c/ha, thereby increasing the value of the gross output by 6,500 roubles. Considering the low costs,

The cost of preparation and a large cost savings owing to its use in tank combinations with pesticides, the - amount of presumptive net revenue was 30066.21 RUB/ha, the cost of 1 kg of grain was 436.96 RUB, and the level of

Spring wheat | Spring barley

Fig. 2. Effect of the humus-based agrochemical ECO-SP on the growth and development of spring cereal crops (2020)

Table 2

The impact of the humus-based pesticide ECO-SP on the occurrence of leaf-rolling diseases in spring wheat (2018-2020)

Variants	Septoriosis	
	prevalence, %	biological efficiency,%
Control - no treatments	25,3	
EKO-SP (2.5 l/ha), application for pre-sowing cultivation + Crop treatment in the tillering phase (1 l/ha) + Crop treatment in the emergence phase (1 l/ha)	19,8-5,5	21,7

Table 3

The impact of the humus-based pesticide ECO-SP on the occurrence of leaf-rolling diseases in spring barley (2018-2020)

Variants	Rhinhosporiosis		Helminthosporiosis	
	prevalence, %	biological efficiency,%	prevalence, %	biological efficiency,%
Control - no treatments	14,3	-	17,9	-
EKO-SP (2.5 l/ha), application for pre-sowing cultivation + Crop treatment in the tillering phase (1 l/ha) + Crop treatment in the emergence phase (1 l/ha)	10,7-3,6	25,2	14,8-3,1	17,3

Table 4

The effect of the humus-based pesticide ECO-SP on spring cereal crop yield (2018-2020)

Variants	Yields, c/ha	Increase	
		c/ha	%
Spring wheat			
Control - no treatments	41,4		
ECO-SP (2.5 l/ha), application under pre-sowing cultivation + crop treatment in tillering phase (1 l/ha) + crop treatment in emergence phase (1 l/ha)	48,3	6,9	16,6
LSD05		3,4	
Spring barley			
Control - no treatments	46,9		
ECO-SP (2.5 l/ha), application under pre-sowing cultivation + crop treatment in tillering phase (1 l/ha) + crop treatment in emergence phase (1 l/ha)	53,4	6,5	13,8
LSD05		2,6	

Table 5

Effect of the humus-based agrochemical ECO-SP on the yield structure elements of spring cereal crops (2020)

Variants	Quantity of plants, pc./m²	Number of stalks to harvest, pcs./m²		Number of grains per ear, pcs.	Weight of 1,000 grains, g	Grain content, g/l
		total	productive			
Spring wheat						
Control - no treatments	502	662/1,32	562/1,12	25,6	32,0	772
EKO-SP (2.5 l/ha), application for pre-sowing cultivation + Crop treatment in the tillering phase (1 l/ha) + Crop treatment in the emergence phase (1 l/ha)	506	688/1,36	586/1,16	26,7	32,9	790
Spring barley						
Control - no treatments	460	570/1,24	524/1,14	17,8	43,8	607
EKO-SP (2.5 l/ha), application for pre-sowing cultivation + Crop treatment in the tillering phase (1 l/ha) + Crop treatment in the emergence phase (1 l/ha)	471	598/1,27	551/1,17	18,2	44,5	627

Table 6

Effect of the humus-based agrochemical ECO-SP on the quality of spring wheat grain (2018-2020)

Variants	Crude gluten content,%	Protein (on dry basis), %	Starch (on dry basis), %	Grain moisture,%
Control - no treatments	24,1	13,6	65,2	13,3
EKO-SP (2.5 l/ha), application for pre-sowing cultivation + Crop treatment in the tillering phase (1 l/ha) + Crop treatment in the emergence phase (1 l/ha)	24,9	13,9	65,9	13,0

Table 7

Effect of the humus-based agrochemical ECO-SP on the quality of spring barley grain (2018-2020)

Variants	Grain size,%	Content, %		Filminess, %
		protein (on a dry matter basis)	starch (per dry matter)	
Control - no treatments	95,3	11,0	51,4	8,47
EKO-SP (2.5 l/ha), application for pre-sowing cultivation + Crop treatment in the tillering phase (1 l/ha) + Crop treatment in the emergence phase (1 l/ha)	96,4	11,2	51,6	8,55

Table 8

Cost-effectiveness of using the humus-based agrochemical ECO-SP on spring cereal crops (2018-2020)

Variants	Productivity, c/ha	Value of gross output, RUB	Production costs, RUB.	Cost price, RUR/c	Net income, RUB/ha	Profitability level, %
Spring wheat						
Control	41,4	49680	21401,79	516,95	28278,21	132,1
EKO-SP	48,3	57960	23333,79	483,10	34626,21	148,3
Spring barley						
Control	46,9	46900	21401,79	456,32	25498,21	119,1
EKO-SP	53,4	53400	23333,79	436,96	30066,21	128,8

Note: The cost of 1 t of spring barley grain is 10,000 roubles, 1 t of spring wheat grain is 12,000 roubles.

profitability of 128.8%. The efficiency of the ECO-SP preparation on spring wheat harvests was even greater: the presumed net revenue was 34626.21 RUB/ha, the cost per 1 kg of grain was RUB 436.96, and the profitability level was 148.3%.

Conclusion

The results of tests carried out with the humus-based agrochemical ECO-SP show its high effectiveness on spring cereal crops. The application of the ECO-SP preparation under pre-sowing cultivation in a dose of 2.5 l/ha and double treatment of crops in the phases of tillering and the beginning of emergence in a dose of 1 l/ha increased spring barley yield by 6.5 c/ha, spring wheat yield by 6.9 c/ha, and gluten content in spring wheat grain by 0.8%.

enhanced spring barley grain size, starch and extractive matter content, and contributed to a minor rise in protein content (by 0.2%), however this rise was within malting barley requirements (9-12%).

The use of the humus-based agrochemical ECO-SP on spring cereal crops was cost-effective because of its high efficiency, low cost and low application rates.

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About the authors:

Lazarev Vladimir Ivanovich, Doctor of Agricultural Sciences, Professor, Deputy Director for Science, Head of the Laboratory of Field Crops Cultivation Technologies and Agroecological Land Assessment, ORCID: http://orcid.org/0000-0002-2931-8560, vla190353@yandex.ru

Zhanna Minchenko,Junior Researcher, ORCID: http://orcid.org/0000-0003-4352-6013, vla190353@yandex.ru

Alexander Bashkatov, Senior Researcher, ORCID: http://orcid.org/0000-0002-9340-0622, vla190353@yandex.ru

EFFICIENCY OF AGROCHEMICALS BASED ON ECO-SP HUMUS SUBSTANCES ON SPRING GRAIN CROPS UNDER THE SOIL AND CLIMATIC CONDITIONS OF KURSK REGION

V.I. Lazarev, Zh.N. Minchenko, A.Ya. Bashkatov

Federal Agricultural Kursk Research Center, Kursk, Russia

The results of the research on the efficiency of the use of agrochemicals based on humus substances ECO-SP in spring grain crops under the conditions of chernozem soils of Kursk region are presented. It was found that the application of the preparation ECO-SP for pre-sowing cultivation at a rate of 2.5 l/ha and double treatment of crops in the tillering and booting beginning phase at a rate of 1 l/ha increased the number of productive stems of spring wheat by 24 pcs./m, the number of grains in the ear by 1.1 pcs., the weight of 1000 grains by 0.9 g, the natural grain weight by 18 g/l, those of spring barley by 27 pcs./m. 0.4 pcs., 0.7 g and 20 g/l, respectively. That contributed to an increase in the yield of spring barley by 6.5 metric centner per ha (c/ha), or 13.8%, in that of spring wheat by 6.9 c/ha, or 16.6%, increased gluten content in the grain of spring wheat by 0.8%, increased the grain size of spring barley, the content of starch and extractives in it, contributed to a certain increase in the protein content (by 0.2%), but the increase was within the requirements for brewing barley (9-12%). Calculations of economic efficiency showed that the use of the preparation ECO-SP in spring barley was economically profitable as it provided a conditional net income of 30,066.21 rubles/ha, with the cost of 1 metric centner of grain equal to 436.96 rubles and a profitability level of 128.8%. The efficiency of the preparation ECO-SP in spring wheat was even higher, i.e. the value of conditional net income was 34,626.21 ruble/ha, the cost of 1 metric centner of grain was 436.96 rubles, the level of profitability was 148.3%.

Keywords: *spring wheat, spring barley, agrochemicals based on humus substances ECO-SP, yield, crop structure, gluten content, septoria, economic efficiency.*

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About the authors:

Vladimir I. Lazarev, doctor of agricultural sciences, professor, deputy director for research, head of the laboratory of technologies for cultivation of field crops and agroecological assessment of lands, ORCID: http://orcid.org/0000-0002-2931-8560, vla190353@yandex.ru

Zhanna N. Minchenko, junior researcher, ORCID: http://orcid.org/0000-0003-4352-6013, vla190353@yandex.ru

Alexander Ya. Bashkatov, senior researcher, ORCID: http://orcid.org/0000-0002-9340-0622, vla190353@yandex.ru

vla190353@yandex.ru